Dow Performance Silicones

Accelerated Weathering and Heat Stability of Various Perimeter Sealants

DOWSIL™

Todd J. Bridgewater, Lawrence D. Carbary; Dow

This document is a summary report of a paper originally presented at the American Society for Testing Materials (ASTM) Symposium on Science and Technology of Building Seals, Sealants, Glazing and Waterproofing held on February 5, 1992.

Summary: Long-term durability study verifies silicone sealants are more stable than urethane sealants.

A study presented to the American Society for Testing Materials (ASTM) indicates that all perimeter sealants do not react in the same way when exposed to long-term ultraviolet (UV) light, temperature and humidity.

The study suggests that resistance to these elements, and others, is linked to the nature of the sealant polymer system. Some manufacturers achieve a degree of weather resistance through the use of fillers, which shade the polymer from ultraviolet light. Still others use chemical additives to absorb the UV radiation and protect the polymer system from degradation. Silicone polymers, however, are inherently resistant to UV light without the use of additives or fillers.

The study sheds new light on the long-term durability and longevity of high-performance perimeter sealants used in construction. Results indicate that long-term exposure to ultraviolet (UV) light, temperature and humidity can cause some urethane perimeter sealants to fail, unlike silicone sealants, which see little variance in physical properties under the same conditions.

Dow technical service and development specialists Todd Bridgewater and Larry Carbary have examined the key factors that could lead to deterioration of sealant properties. They used accelerated weathering lab equipment and ovens to demonstrate the physical effects on various two-part urethane and one-part silicone perimeter sealants currently used in construction weathersealing applications.

This summary reports on their findings.

Introduction

Perimeter sealants are subjected to many extreme weather and light conditions depending on which face of a building they are placed upon, the type of substrate they come in contact with, and the weather patterns of a given geographic location.

The ability of a sealant to perform effectively over the long-term is, therefore, heavily influenced by its ability to withstand temperature, UV exposure and humidity.

The Bridgewater/Carbary study examined seven perimeter sealants – four two-part urethanes, one three-part urethane and two one-part silicone products – which are commercially available (see Table I at right). The sealants were then examined through 14 different time-specific tests, ultimately yielding more than 580 test specimens.

The adverse effects of long-term weathering on four out of five of the urethane sealants in this test indicate that urethane sealant failures, which are sometimes attributed to poor workmanship, adjacent materials or damp working conditions, may be caused simply by exposure to UV light, temperature and humidity. Those silicone sealants tested, however, were found to change very little and perform effectively under similar long-term UV light, temperature and humidity conditions.

Testing Meets ASTM Industry Standards

Test samples of the seven perimeter sealants were prepared for testing in accordance with ASTM standards. They were prepared on precast concrete samples per Federal Specification SS-S-200D using manufacturers' recommended primer.

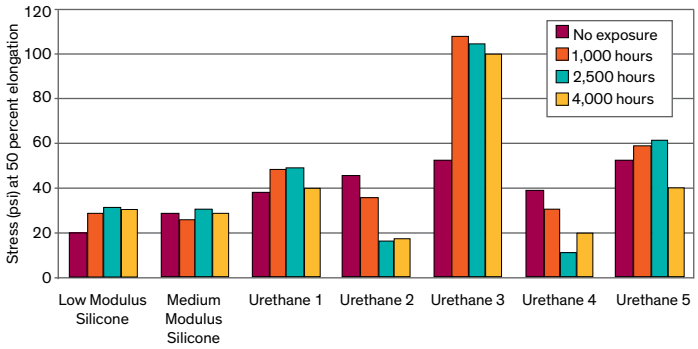
The sealants were allowed to cure for 21 days and were then subjected to these four test conditions using accelerated weathering equipment and lab ovens:

- ASTM G 53 – QUV (Cycling UV light exposure and 100 percent humidity)
- ASTM C 1087 – Constant UV light exposure
- 30°C (86°F) at 100 percent humidity
- 50°C (122°F) at 100 percent humidity.

Table I. Description of Studied Perimeter Sealants

Sealant	Type
Silicone - LM	One-component, low-modulus silicone sealant
Silicone - MM	One-component, medium-modulus silicone sealant
Urethane #1	Two-part, polyurethane sealant
Urethane #2	Three-part, epoxidized polyurethane terpolymer sealant
Urethane #3	Two-part, low-modulus/high-elongation polyurethane sealant
Urethane #4	Two-part, non-priming polyurethane sealant
Urethane #5	Two-part, non-sag, low-modulus polyurethane sealant

Figure 1. Comparative Performance Capabilities of Silicone and Urethane Sealants – QUV (UV and Humidity)



The sealants were then checked for durometer and stress at 25 percent and 50 percent elongation (according to ASTM C 1135) after 1,000, 2,500 and 4,000 hours of exposure, and then compared to a control sample that had not been exposed to accelerated weathering.

Silicone Sealants Tested Found Superior

The study accelerated those conditions that are typically experienced on the exterior vertical walls of buildings where high-performance perimeter sealants must perform. The samples tested are widely used, currently available high-performance perimeter sealants that are often represented and specified as equals in performance.

Instead of performing equally, however, most of the urethane sealants were adversely affected by UV and alternate UV and moisture (accelerated weathering) exposure. One urethane showed a notable increase in durometer and modulus, making it so rigid that it may not perform effectively in moving joints; while, after thorough cure, three other urethanes exhibited substantial decreases in durometer and modulus and became soft and tacky. The fifth did not change substantially.

The elastomeric properties of silicone sealants, after complete cure, changed only slightly when exposed to UV light and humidity in the same four tests.

During the study, when the same sealants were exposed to UV light alone, the properties of urethane sealants were even more dramatically changed, while silicone sealants were comparatively unaffected.

In other words, the performance capabilities of urethanes were diminished relative to their elastomeric flexibility and sealing capabilities, while the silicones tested did not experience such dramatic changes. This is shown in Figure 1, in which the modulus of each sealant is measured at 50 percent elongation.

"The study reveals that while the silicone and urethane sealants we tested are often specified as equals, this data shows that urethane materials do not have the same weather resistance or the durability of silicones."

Todd J. Bridgewater

"There's a tendency to blame poor workmanship, adjacent materials or damp working conditions for the failure of urethane sealants. This may be true in some instances, but our work shows that the urethane sealants we studied failed primarily due to UV light exposure."

Lawrence D. Carbary

Conclusion

The study concludes that, in general, urethane sealants do not have the long-term weather resistance or durability of silicone sealants. Urethane sealants were shown to experience weathering degradation that may vary depending upon their position on a building relative to the sun.

Silicone sealants, on the other hand, show little variance and should perform effectively independent of their position to the sun.

Urethane sealants may undergo significant performance changes in a relatively short period of time when fully exposed to weathering elements, while silicone sealants will not.

This observation is supported by examinations in the field of silicone sealants that were applied 20 years ago and are still performing with no visible change in physical properties.

For More Information

This information has been condensed from a presentation by Todd J. Bridgewater and Lawrence D. Carbary at the ASTM Symposium on Science and Technology of Building Seals, Sealants, Glazing and Waterproofing, held February 5, 1992.

For a complete copy of all symposium papers (Titled STP1200), or of this study, contact:

ASTM Customer Services
1916 Race Street
Philadelphia, PA 19103
(610) 832-9585

Dow manufactures a complete line of silicone products for the construction industry, including glazing and weatherproofing adhesive/sealants, elastomeric waterproof coatings for above-grade applications, insulating glass and sash sealants, pavement joint sealants and roofing systems.

For information on all of these products, contact your local Dow Customer Service Representative or visit **consumer.dow.com/ContactUs.**

LIMITED WARRANTY INFORMATION – PLEASE READ CAREFULLY

The information contained herein is offered in good faith and is believed to be accurate. However, because conditions and methods of use of our products are beyond our control, this information should not be used in substitution for customer's tests to ensure that our products are safe, effective and fully satisfactory for the intended end use. Suggestions of use shall not be taken as inducements to infringe any patent.

Dow's sole warranty is that our products will meet the sales specifications in effect at the time of shipment.

Your exclusive remedy for breach of such warranty is limited to refund of purchase price or replacement of any product shown to be other than as warranted.

TO THE FULLEST EXTENT PERMITTED BY APPLICABLE LAW, DOW SPECIFICALLY DISCLAIMS ANY OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY.

DOW DISCLAIMS LIABILITY FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

S2D 91081/E26531 Form No. 62-320-01 C